22624

WE CLAIM:

1. A method for rapid tomographic measurement of conductivity distribution in a sample, comprising the steps of:

(a) launching electrical excitation signals simultaneously into a sample from a multiplicity of locations distributed in said sample;

(b) measuring at a multiplicity of locations in said sample at least one parameter selected from the group which consists of potential difference and magnetic field strength resulting from said electrical excitation signals; and

(c) correlating the measured potential differences or magnetic field strengths with the launched excitation signals to provide conductivity distribution cross section in said sample.

2. The method defined in claim 1 wherein the electrical excitation signals are launched as orthogonal signals into said sample.

3. The method defined in claim 2 wherein the electrical excitation signals are launched as orthogonal sinusoidal signals into said sample.

4. The method defined in claim 3 wherein in the measurement of said parameter at least one voltage component a_i, b_i is determined using a defining equation of the Fourier-analysis cosine coefficients according to the formula:

$$a_i = \frac{2}{T} \int_0^T U_G(t) \cos(i\omega_0 t)\, dt$$

where a_i = peak value of the measured voltage amplitude;
ω_0 = fundamental frequency of the excitation signal;
i = the index of the excitation signal from 1 to ∞;
$U_G(t)$ = measured potential difference; and
t = time
or

using a defining equation

of the Fourier-analysis sine coefficients according to the formula:

$$b_i = \frac{2}{T} \int_0^T U_G(t)\sin(i\omega_0 t)\,dt$$

where b_i = peak value of the measured voltage amplitude phase shifted by 90°;

ω_0 = fundamental frequency of the excitation signal;

i = the index of the excitation signal from 1 to ∞;

$U_G(t)$ = measured potential difference; and

t = time.

5. The method defined in claim 4 wherein the coefficients a_i, b_i are used to calculate a complex impedance of the sample.

6. The method defined in claim 1 wherein the excitation signals launched into said sample are coded signals.

7. The method defined in claim 1 wherein the excitation signals launched into said sample can assume either of only two possible amplitudes.

8. The method defined in claim 1 wherein at least three electrodes in spaced apart relationship are inserted into said sample for launching said excitation signals into said sample.

9. The method defined in claim 1 wherein at least two electrodes in spaced apart relationship are inserted into said sample for measuring potential differences therein.

10. The method defined in claim 1 wherein at least three electrodes in spaced apart relationship are inserted into

said sample for launching said excitation signals into said sample and at least two electrodes in spaced apart relationship are inserted into said sample for measuring potential differences therein, said electrical excitation signals are applied to said sample at at least a part of the three electrodes so that a potential distribution occurs in the sample and potential differences are measured at said at least two electrodes.

11. The method defined in claim 10 wherein said electrical excitation signals are applied simultaneously to said at least three electrodes and the measured potential differences are correlated proportionally with supplied electrical excitation signals.

12. The method defined in claim 1 wherein the electrical excitation signals are launched into said sample from the same electrodes with which measurements of the potential differences are made.

13. The method defined in claim 1 wherein said electrodes are spikes driven into the sample hand having electrically decoupled surfaces for applying said electrical excitation signals to said sample and measuring potential differences therein.

14. The method defined in claim 1 wherein said electrical excitation signals are applied with a high-ohmic current source.

15. The method defined in claim 1, further comprising exciting said sample by energizing two coils in contact with said sample.

16. The method defined in claim 1 wherein a magnetic field strength is measured by a magnetic field sensor brought into contact with said sample.

17. The method defined in claim 1 wherein the electrical excitation signals are applied to at least part of a plurality of excitation coils or excitation electrodes in contact with the sample and as a result of conductivity distribution therein a current density distribution and consequent magnetic field strength distribution are effected in the sample.

18. The method defined in claim 1 wherein the electrical excitation signals are applied to at least part of a plurality of excitation coils or excitation electrodes in contact with the sample and a correlation is made between a measured field strength distribution in proportion to the electrical excitation signals supplied.

19. The method defined in claim 1 wherein at least two of said electrodes for measuring potential difference and at least one magnetic field sensor for measuring a magnetic field strength are provided in said sample.

20. The method defined in claim 1 wherein at least three electrodes for applying an electrical excitation to said sample and at least one magnetic field sensor for measuring a magnetic field strength are provided in contact with said sample.

21. The method defined in claim 1 wherein said electrical excitation signals are formed by an alternating current fed to said sample.

22. The method defined in claim 1 wherein electrical excitation signals in the form of an alternating voltage are fed to the sample and the current amplitude in a conductor feeding said electrical excitation signals to the sample is measured.;

23. An apparatus for the rapid tomographic measurement of a conductivity distribution in a sample, comprising:

an electrical excitation source coupled with said sample for applying electrical excitation signals thereto;

at least one device coupled with said sample for measuring a potential difference or magnetic field strength therein in proportion to the electrical excitation signals supplied thereto; and

circuitry for correlating a measured potential difference or magnetic field strength proportionally with the supplied electrical excitation signals.

24. The apparatus defined in claim 23 wherein said circuitry includes a control and computing unit which produces electrical orthogonal excitation signals and enabled a correlation of measured potential differences or magnetic field strengths proportionally with the electrical orthogonal excitation signals.

25. The apparatus defined in claim 24 wherein said control and computing unit comprises at least two generators for producing orthogonal electrical excitation signals.

26. The apparatus defined in claim 25, further comprising conductors for supplying said electrical excitation signals to the sample.

27. The apparatus defined in claim 26 wherein said circuitry includes an evaluation unit for calculating a conductivity distribution in said sample.

28. The apparatus defined in claim 27 wherein the electrical excitation source comprises at least three electrodes engaged in said sample and in spaced-apart relationship.

29. The apparatus defined in claim 28 wherein said at least one device comprises at least two electrodes in said sample for measuring electromagnetic fields therein.

30. The apparatus defined in claim 23 wherein the electrical excitation source comprises at least three electrodes

engaged in said sample and in spaced-apart relationship, said electrodes being so configured as to enable a potential difference measurement between said electrodes.

31. The apparatus defined in claim 30 wherein said electrodes are in the form of spikes having excitation electrode surfaces electrically decoupled from potential measuring surfaces respectively along jackets and tips of the respective electrodes.

32. The apparatus defined in claim 23 wherein said source includes at least two coils as the exclusive source of excitation signals or in conjunction with excitation electrodes.

33. The apparatus defined in claim 23 wherein said device includes at least one magnetic field sensor as the exclusive means for measuring magnetic field strength or in conjunction with at least one electrode.

34. The apparatus defined in claim 23 wherein said circuitry includes a separating stage which decomposes the measured signals in proportion to the applied electrical excitation signals.